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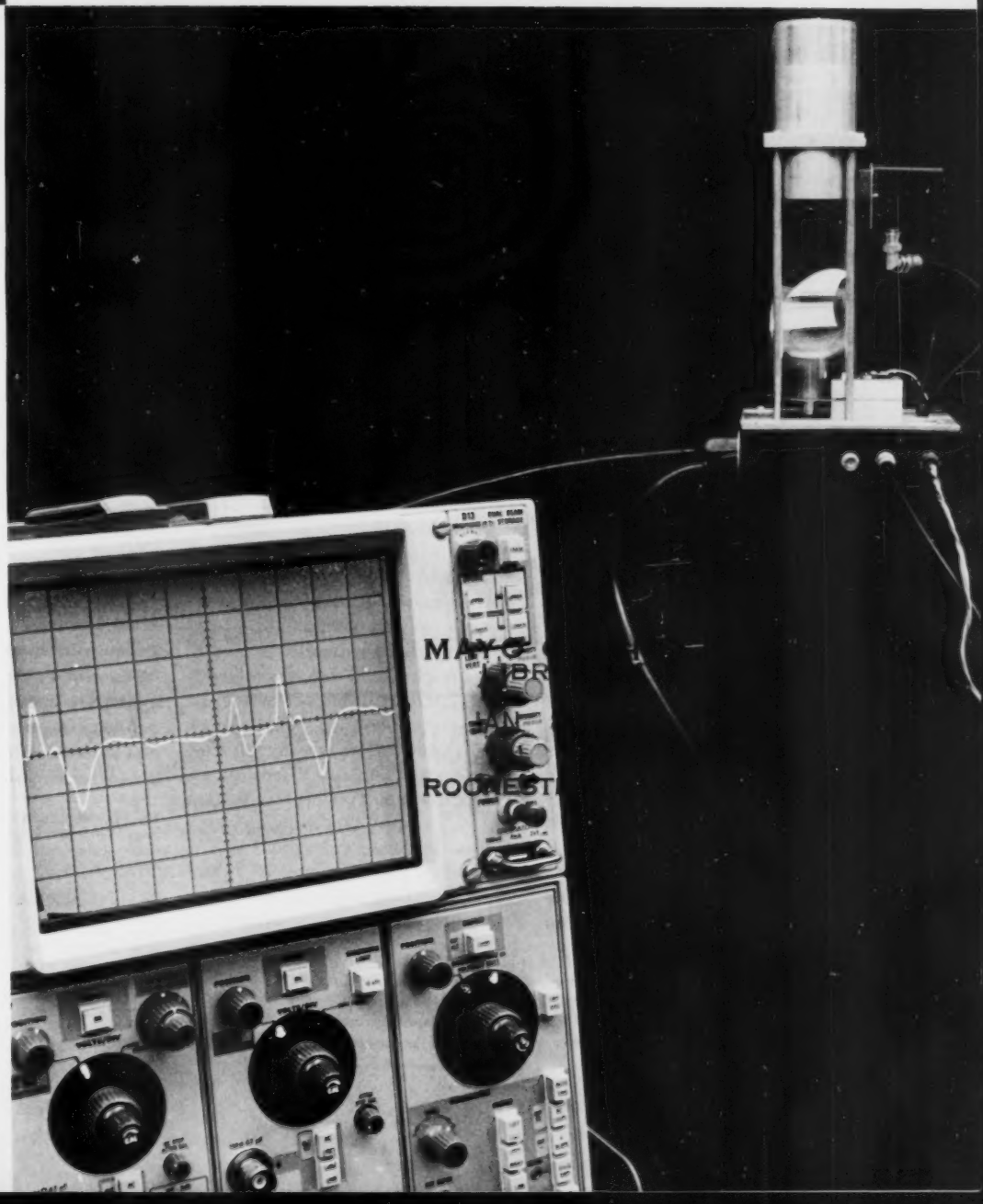

UNITED STATES DEPARTMENT OF COMMERCE

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CONTENTS

275 Topografiner Developed

276 New Apparatus Determines Particle Size Distribution in Real Time

277 Scanning Thermal Detector Developed

278 New Pressure Gage Service

279 1972 Stratton and Rosa Awards

280 NBS to Study Impact of ASCII as a Federal Standard

282 Cycle of Metals in Biosphere Studied

284 Conference Briefs

285 Optical Radiation News

286 NSRDS News

288 Unified 3-Dimensional Measurement Program

290 Referee Method for Determining Calcium in Serum

293 Publications of the National Bureau of Standards

302 Index to the Technical News Bulletin

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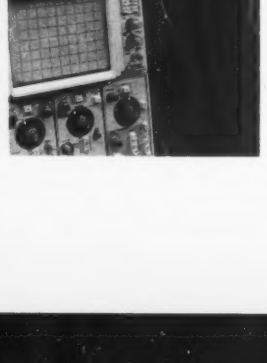

COVER: A scanning thermal detector that detects minute temperature changes has been developed. The detector's output can be stored electronically or displayed on an oscilloscope. See page 277 for further details.

U.S. DEPARTMENT OF COMMERCE
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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized as follows:

The Institute for Basic Standards

The Institute for Materials Research

The Institute for Applied Technology

Center for Computer Sciences and Technology

Center for Radiation Research

Center for Building Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of NBS.

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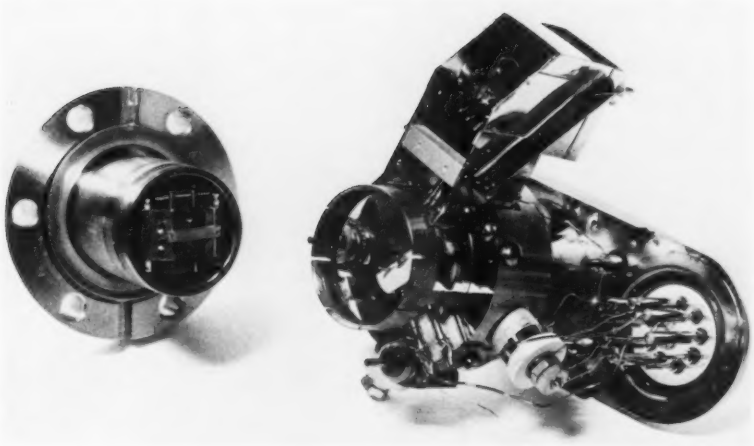


View of the topografiner. A rectangular metal specimen is mounted on the component at the left; the field emission probe, mounted on the assembly at the right, will be positioned about 10nm from the specimen when the two pieces are assembled.

TOPOGRAFINER DEVELOPED

High-Resolution Instrument Measures Surface Finish

A new instrument for high-resolution topographic mapping of metal surfaces has been developed at NBS.

The instrument, called a topografiner, measures the microtopography of metals without touching the surface. A preprototype unit, developed by Dr. Russell Young and Fredric Scire, has a resolution of 30 Å (3×10^{-9} m) perpendicular to the surface and 4,000 Å in the plane of the surface. After refinement, the instrument is expected to detect single-atom steps (3Å).[1,2,3]

The uniqueness of the topografiner lies in its ability to combine high-resolution topographic mapping with concurrent secondary-electron-emission pictures of the surface. However, the most important characteristic of the instrument is that the probe does not contact the surface and cause damage.

This instrument should be particularly useful in the area of surface-finish metrology where there is increased demand for refined measurements. The finish of ceramic substrates for integrated circuits and single-crystal silicon wafers is of vital interest to the growing electronics industry. Many other industries require meticulous surface finishing and characterization: Instrument shafts and bearings utilizing extremely thin dry-film lubricants require a high-quality surface finish; the light-scattering characteristic of reflecting optics in the ultraviolet region is determined by the surface finish of the coating; the wavelength dependence of emissivity is dependent on the physical nature of the surface; and topographic mapping of diffraction gratings is a continuing difficult problem.

The topografiner can be used in surface-science experiments to study the density of single- and multiple-atom steps on single-crystal surfaces, adsorption of gases, and processes involving electronic excitation at surfaces.

A zoom feature allows the emitter to be withdrawn from the surface by increased emitter-specimen voltage. Under these conditions, the specimen surface can be rapidly scanned at low resolution before zooming in on a portion of the surface for detailed study.

A prototype instrument is presently under construction at NBS that the scientists believe will increase the vertical resolution to 3 Å and the horizontal to 200 Å. Vertical resolution of 3 Å will permit examination of single-atom steps. Attempts will be made to increase the scanning area of the new instrument to a 10 mil square area (1 mil = 2.54×10^{-5} m). Improvements to decrease both the scan time and the turn-around time are being made in the prototype unit.

Work is also being done to improve the quality of the secondary-electron-emission pictures and to obtain these pictures simultaneously with the profiles.

When a field emitter with a typical radius of 100-10,000 Å is brought close to a conducting surface while

continued on page 292

New Apparatus Determines Particle Size Distribution in Real Time

Dr. Gravatt positions a device that blows a jet of dust-laden air across a laser beam. The particle size distribution is determined in real time by finding the ratio of the amount of light scattered at two angles.

An apparatus that determines almost instantly the size distribution of particulate matter in air has been developed. This apparatus is characterized by the fact that the particle size measurements are made with only a minimum amount of error being introduced by the index of refraction of the particle.

In addition to its obvious potential in air pollution monitoring, the device may find wide application in general aerosol studies—cloud physics, fuel atomization, paint spraying, and smoke characterization, for example—and in studies of the physiological effects of particulates.

The apparatus,[1] which is based on the simultaneous measurement of the intensity of light forward-scattered from a particle at two angles, was developed by Dr. C. C. Gravatt, Polymers Division, as part of the NBS Measures for Air Quality program, which provides technical support for the U.S. Environmental Protection Agency.

Besides its basic function of determining particle size distribution, the apparatus can also count the total number of particles—up to 50,000 per second—and can be modified to provide information about the shape and chemical composition of the particles.

In the apparatus, air carrying the particles to be measured is blown through a beam light from a continuous wave laser. Light scattered from individual particles is collected by separate annular rings of fiber optics set at 5 and 10 degrees to the laser axis, and detected by separate photomultipliers. For the measurement of particle size, the electronic system then generates for each particle an output ratio pulse that is a function of the particle size.

The choice of the two angles at which to measure the scattering intensity depends on the size distribution of interest. The 5/10 degree arrangement provides the best resolution over the diameter range 0.3 to 4 microns; 5/2.5 degrees is more effective for larger particles, and 20/10 degrees is better for smaller particles.

The strong dependence of scattered intensity upon particle refractive index has limited the usefulness of some scattering approaches to the sizing of airborne material. Measuring the ratio of light scattered at two angles makes the size determination largely independent

of refractive index. In addition, knowledge of the refractive index can provide a handle on the chemical nature of the particle. By a modification of the particle sizing technique, it is possible to classify the particulates as to whether they are water-like, silicate-like, carbon-like, or metallic.

When information on the shape of the particles is needed, polarization analyzers can be inserted into the system to determine the ratio of depolarized/nondepolarized scattered light. This ratio provides a measure of the nonsphericity of the particle. Knowledge of particle shape could be important in a situation where rod-shaped particles, e.g., asbestos, are being monitored because they are suspected of being cancer inducers.

The effects of particulates in air can range from the housewife's annoyance over constant dusting to the often fatal "black lung" found among coal miners. Although there is always a background cargo of particulates in the air resulting from winds, volcanic eruptions, and other natural sources, it is largely the particulates sent into the air by man that offend both lung and eye. In heavy industrial areas fallout rates of 200 tons of dust per square mile per month are not uncommon.

From a physiological standpoint, particles in the 0.1-5 micron diameter range are of primary interest. Generally speaking, particles smaller than 0.1 micron are believed to be inspired and expired without major interaction in the lung, and particles larger than 5 microns tend to be filtered by the cilia before reaching the lungs and to settle out of the air rather quickly.

[1] Gravatt, C. C., Jr., Real time measurement of the size distribution of particulate matter in air by a light scattering method, J. Air Poll. Cont. Assn., in press.

Scanning Thermal Detector Developed

A scanning thermal detector, sensitive enough to detect a person entering a room at more than 50 feet or to sense minute changes in the temperature of a piece of equipment, has been developed by Joshua Stern of the Bureau and Michael D. Stern of the U.S. Naval Ordnance Laboratory, White Oak, Md. Based upon the inexpensive plastic (polyvinyl fluoride) infrared detector announced last year by NBS,[1] the scanner was built for NASA to illustrate the usefulness of polymer film sensors in real-life situations.

The performance characteristics illustrated by this preliminary model—and it must be emphasized that the configuration and operation of the unit are merely points of departure for further development—lend themselves to a great variety of applications: fire prevention and detection, security, equipment monitoring, perhaps patient monitoring in fever situations, and nondestructive testing. Nondestructive testing would make use of changes in thermal conductivity associated with invisible flaws.

In the prototype, a plane mirror is rotated at 10 rpm to scan the room. The mirror, centered on a revolving shaft, is tilted 45° from its rotational axis. Radiation is reflected from the rotating mirror up to a concave mirror having a 2-inch focal length, and from this mirror onto a polymer film sensor 1/4 inch in diameter. The output from the detector for 128 uniformly spaced points on the 360° scan is stored in a digital memory. Once the memory is filled (in 6 seconds), the circuitry will trigger an alarm if a thermal event exceeding a preselected value occurs at any of the 128 points of the scan.

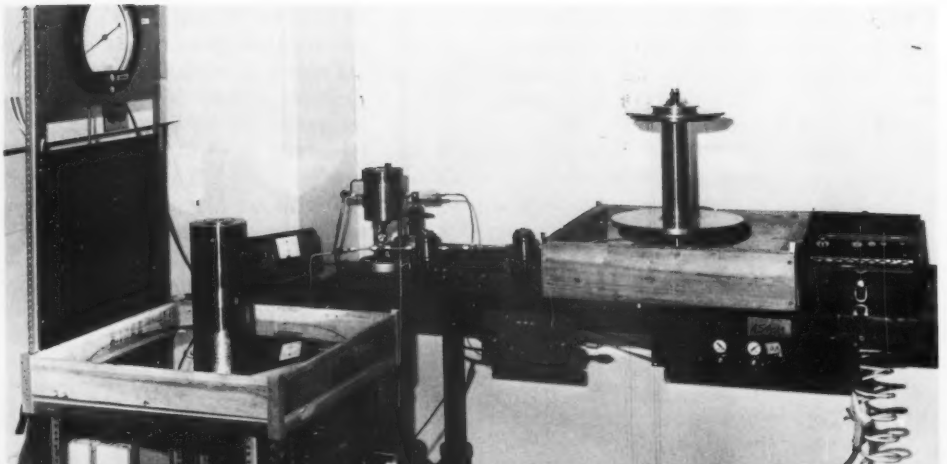
The electronics in this model are set to re-record the thermal baseline or "signature" of the field of view after each set of 64 scans (approximately 6 minutes). In this way, the response of the detector to slowly changing temperatures, such as result from heating/cooling cycles, diurnal variations, etc., is limited so that they will not cause false alarms. The reset period could be easily modified to suit specific applications.

The unit could be set to go off if a person entered or left a room or changed his location in the room. Similarly, it could scan walls in which electrical wiring may exist, or apparatus distributed about the room, and signal when abnormal changes in temperature occur.

The sensor's output can also be displayed on an oscilloscope. Discrete objects that differ in temperature from neighboring regions will then appear as excursions from the baseline. An alternative to an alarm is to watch the scope for deviations of the trace from previous recordings.

The plastic sensor at the heart of this device is made by subjecting polyvinyl fluoride films to applications of heat, pressure, deformation, and an electric field. The sensors formed by this process are sensitive, inexpensive, relatively insensitive to shock, nonhygroscopic, and can be made large or small as desired.

[1] Cohen, J., Edelman, S., and Vezzetti, C., Pyroelectric effect in polyvinyl fluoride, Nature Phys. Sci. **233**, 12 (Sept. 6, 1971) or see Nat. Bur. Stand. (U.S.), Tech. News Bull. **56**, No. 3, 52-53 (1972).



Equipment used by NBS for piston gage calibration by the cross-float method.

NEW PRESSURE GAGE SERVICE

A new data evaluation service to improve the general accuracy of pressure measurements for industry, scientific laboratories, and government agencies is now available from the Bureau. This program involves NBS analysis of data on pressure gage calibrations sent in by outside laboratories.

Under the new service, data taken during the cross-float of piston gages or the calibration of transducers will be sent to the Bureau in a standard worksheet format. The submitted data will then be processed on a computer using special programs developed by Dr. Peter Heydemann and Bernard Welch. In these programs essential corrections are automatically applied, several least squares fits are made, and the sets of coefficients that best characterize the gage or transducer are determined and supported with a statistical analysis.

The submitting laboratory will be sent a report containing:

·Input data,

·Type and magnitude of corrections applied,

·Coefficients resulting from the data analysis and their standard deviations, and

·Plots and tables of residuals to illustrate gage behavior.

The calibration results will also be discussed in writing by an NBS pressure expert and a set of constants and their uncertainties will be recommended. As usual, NBS will use this opportunity to improve or facilitate the measurement of pressure.

The cost of this service is $65 per range, and the usual turn-around time is four working days.

To participate in this service laboratories should request a set of worksheets, their instructions, and a reprint of Piston Gages[1] from Dr. P. L. Heydemann, A149 Metrology Building, National Bureau of Standards, Washington, D.C. 20234, phone (301) 921-2121. However, a better method is for laboratories to send a participant to the new NBS training program on the calibration and use of piston gages.[1] These 2-day sessions, costing $85 per person and limited to six individuals at a time, will be held as demand requires.[2]

[1] Heydemann, P. L., and Welch, B. E., Piston Gages. Text used in training program.

[2] Pressure calibration course offered, Nat. Bur. Stand. (U.S.), Tech. News Bull. **56**, No. 8, 185 (1972).

1972 STRATTON & ROSA AWARDS

Two major NBS awards were recently presented to Bureau staff members—the Stratton Award to Dr. Kenneth M. Evenson and the Rosa Award to Dr. Emanuel Horowitz. Each award consists of a $1,500 honorarium and a bronze plaque.

Dr. Evenson received the Samuel Wesley Stratton Award for an achievement in frequency measurement which inaugurated a new era in measurement science. His measurement of the frequency of an infrared laser beam was hailed earlier this year as a measurement breakthrough which for the first time linked the international standards for length and time.

The Stratton Award is given yearly by the Bureau for outstanding scientific and engineering achievement by a staff member.

In describing the importance of Evenson's achievement earlier this year, Dr. Lewis M. Branscomb, then the Bureau's Director, said: "Ever since Albert Einstein showed that time can be considered the fourth dimension of the space in which we live, scientists have looked forward to the possibility of using one gage—one 'yardstick', so to speak—not only for the three dimensions of space but for the fourth dimension of time as well. To interchange clocks and rulers, scientists must know the speed at which light travels, which is equal to its wavelength times its frequency. With this demonstration that both the space (wavelength) and time (frequency) dimensions of a single light source can be measured with prodigious accuracy, this goal is now within our grasp."

Dr. Evenson joined NBS in 1963 after teaching physics at Purdue University and Oregon State University. He received his physics degrees from Montana State College (B.S.) and Oregon State University (M.S. and Ph. D.). He was a Fulbright Scholar at the Universitaet Tubingen in Germany from 1955 to 1956. At NBS, he has worked mainly with lasers and their applications to fundamental physical research. He is a member of the American Physical Society.

The Edward Bennett Rosa Award, established by NBS in 1964, recognizes outstanding achievements in the development of standards in the measurement field. It acknowledges standardization committee and similar cooperative achievements as well as contributions that are published in the scientific and technical literature. Dr. Horowitz is being honored for his "distinguished accomplishments in both science and management toward the establishment of engineering and materials standards, and toward effective collaboration among Government, industry, academia, and voluntary standards groups to achieve needed standards."

As Deputy Director of the Institute for Materials Research, Dr. Horowitz is responsible for the executive direction and planning of the Institute's programs and for activities in the fields of polymers, metallurgy, inorganic materials, physical chemistry, analytical chemistry, and reactor radiation.

During his 21 years at NBS, Dr. Horowitz has been continuously active in standardization, both at national and international levels, and is much in demand as a standardization expert. A member of the American Society for Testing and Materials since 1951, he is the retiring Chairman of the select ASTM Standing Committee on Research, the key technical advisory committee of the Society which recommends policy to the ASTM Board of Directors and the Managing Director. From 1952 to 1962, he served as a technical expert on ASTM Committee D-13 (Textiles) and is currently serving on Committee D-20 (Plastics). In 1964-65, he spent over a year as Scientific Assistant to the Assistant Secretary of Commerce for Science and Technology, providing advice and assistance to the White House Office of Science and Technology and functioning as the Executive Secretary of the Commerce Technical Advisory Board which was dealing with such problems as voluntary standards, transportation, and invention and innovation.

Dr. Horowitz is nationally known for his efforts to solve the critical need for improvement of synthetic materials for surgical implants. As a member of the Board of Directors of the Association for the Advancement of Medical Instrumentation, he is working with standards committees of that organization and representatives of the Food and Drug Administration to establish effective collaboration between Government, industry, and professional organizations to improve synthetic implant materials, their standardization, production, and use.

Since 1964, Dr. Horowitz has been the chief U.S. Government delegate to six international conferences of the International Organization for Standardization (ISO). He is the only U.S. Government member of ISO Committee TC-61 (Plastics) on the chemical analysis, characterization and evaluation of plastics.

Dr. Horowitz received his education in chemistry at the City College of New York (B.S.) and George Washington University (M.S. and Ph. D.). He has also done graduate work at Columbia University and the University of Illinois.

NBS TO STUDY IMPACT OF ASCII AS A FEDERAL STANDARD

The Bureau has launched a study of the significance and impact of the *A*merican *S*tandard *C*ode for *I*nformation *I*nterchange (ASCII), the first full-scale survey since ASCII's adoption in March 1968 as a mandatory Federal Standard.

Developed to facilitate information interchange among computer installations and communications facilities, the Federal Standard specified that all new computers and related configurations brought into the Federal Inventory be compatible with ASCII.

The NBS study will serve to improve the effectiveness and understanding of the Federal computer standardization process.

Specific objectives of the effort are to:

·Highlight the effect of ASCII as a means for increasing the efficiency of Federal computer utilization, and

·Extend necessary ASCII implementation to meet intended objectives as stated in several other Federal information processing standards (FIPS PUBS 1, 2, 3, and 7).

BACKGROUND ON ASCII

ASCII was adopted as a voluntary American National Standard by the American Standards Association, a predecessor of the American National Standards Institute (ANSI), in 1963. It was revised in 1965, 1967, and 1968. ASCII was adopted as a Federal Standard by Presidential approval March 11, 1968. Implementing instructions for ASCII were promulgated by the Secretary of Commerce on March 7, 1969. The General Services Administration issued instructions for the inclusion of ASCII in Federal procurements in a Federal Property Management Regulation of April 7, 1970. ASCII has also been adopted as an international recommendation by the International Organization for Standardization (ISO) and the Consultative Committee on International Telegraph and Telephone (C-CITT).

When ASCII was developed, several character codes had already been implemented by various manufacturers and users: namely BCD, Fieldata, Hollerith, and Baudot codes. Only after a careful review of current coding practices, and after a comprehensive program of original research and code design, was ASCII approved as a voluntary standard. At that time (1963), ASCII was an anticipatory standard. It is a seven-bit code consisting of a set of 128 defined control and graphic characters.

ASCII was adopted to achieve an acceptable standard for information interchange among the many and diverse ADP installations. Additionally, instructions for ASCII implementation (FIPS PUB 7) stated that the introduction of ASCII standards "for character coded and program storage within installations and conversion of appropriate existing files shall also proceed as rapidly as possible."

ACHIEVING COMPATIBILITY THROUGH ASCII

The importance of ASCII's adoption and use can clearly be seen in at least three significant areas. These are *Computer Utilization*,

Computer Networking, and *High Level Programming Languages*.

Effective and economic computer utilization by Federal agencies is dependent upon compatibility in the interchange of information in machine-processible form within and between information systems. A standard coded character set is a basic requirement for such compatible interchange of information.

Computer technology, as manifested by computer networking, makes it increasingly difficult to distinguish between information which is always encoded for internal use within an installation and that information which is subject to interchange. Due to the increased benefits derived from networking computer systems, the need for a standard code for all recorded data becomes more apparent.

A primary purpose of high level programming language standards such as COBOL and FORTRAN is to promote interchangeability of programs for use on a variety of ADP systems. Here the lack of standard character codes for the data processed by compiled programs written in these high level languages clearly prohibits wide interchange of computer software. This lack of standardization is reflected in different collating sequences of various character codes and the character-sensitive bit-oriented nature of imbedded constants in computer programs.

The NBS Federal Information Processing Standards (FIPS) Program is designed to make computer use more effective by resolving incompatibility problems that exist among equipment, software, computer-generated data, and computer services. ASCII was approved as a Federal Standard to help solve some of the major problems of incompatibility.

SPECIFIC ISSUES OF THE STUDY

The proposed NBS effort will address the following issues:

·FIPS PUB 7 provides implementation instructions for ASCII and its representation on perforated paper tape and 800 CPI magnetic tape. These instructions state that all computers and related equipment configurations brought into the Federal Government on or after July 1, 1969, must have the capability to use ASCII and be able to receive and generate data on 800 CPI magnetic tapes and perforated paper tapes recorded in ASCII. Federal departments and agencies have already been asked for an initial determination of the extent of ASCII implementation. Later queries will address associated conversion difficulties and other related problems.

·FIPS PUB 7 also states that ASCII shall be used whenever data is interchanged between two installations which have equipment conforming to the Standard. The extent to which ASCII is specified in these interchange situations will be identified.

·FIPS PUB 7 specifies those ASCII-related character sets that are permissible for Federal use (i.e., basic set, subsets, extended sets, and expanded sets). The present use of these allowable sets and related standardization or implementation problems will be determined.

·FIPS PUB 7 provides procedures for obtaining waivers on implementing ASCII Standards. The effectiveness of these procedures for standards management will be ascertained.

·FIPS PUB 7 states that existing computer systems would be converted to ASCII on an evolutionary basis as equipment is replaced, reprogrammed, or redesigned. The extent to which this has occurred will be determined.

·ASCII is a fundamental standard in that it provides a base for the derivation of a family of uniform standards. Other standards necessary to achieve increased compatibility will be decided.

NBS PLANS

NBS has overall responsibility for ADP standards management within the government as prescribed by Public Law 89-306. Very important to this function is the identification of difficulties (if any) that Federal computer customers have experienced in complying with new standards. Valuable feedback is thus obtained for ongoing standards development projects.

Though ASCII is but one of 17 voluntary standards adopted for Federal use, its *particular significance* lies in its ability to provide a basic character set and codes upon which other standards are based.

NBS believes it essential to determine ASCII's impact as a Federal Standard in order to be more effective in its continuing responsibility for Federal Information Processing Standards (FIPS). In particular, NBS considers it vital to protect user investments in automated systems, to improve computer utilization practices, and to encourage computer industry competition and provide for effective information interchange.

To carry out the ASCII study NBS will establish a task group composed of representatives from State and Federal agencies, trade associations, communications and terminal equipment manufacturers, hardware and software producers, and nongovernment user groups. This Federal and industry task group will be organized under the auspices of the Federal Information Processing Standards Coordinating and Advisory Committee, FIPSCAC, an interagency group that advises NBS on ADP standards matters. The Chairman of the Task Group will be Dr. Robert R. Johnson, Vice President for Engineering of the Burroughs Corp. and a member of the National Academy of Sciences' Evaluation Panel for the NBS Center for Computer Sciences and Technology.

CYCLE OF METALS IN BIOSPHERE STUDIED

Mercury, cadmium, lead, tin, and arsenic are commonly classed as pollutants when found in water supplies. Even in very small quantities they can be toxic to man, animal, and plant. How do metals move through our biosphere? How do they combine with other metals or change into forms that are more lethal to man? Can these processes be defined and controlled?

In an attempt to provide a better understanding of these problems, the Bureau has initiated a study to characterize biological and other forces that mobilize and transport heavy metals in natural water systems. Such an undertaking is made possible by the Bureau's long-term interest and experience in organometallic chemistry and the biological corrosion of materials.

This program is partially supported by a research grant awarded to NBS by the Environmental Protection Agency to study pathways that allow conversion of elemental and inorganic mercury to organometallic forms, the rates of such transformations, and the chemical or biological conditions favoring or inhibiting them.

Such information is vital to establish timely standards, and to establish the basis for control procedures and policy for metal pollutants in the waterways. Studies on the rate of methylmercury formation, for example, are essential to determine the background level for an objective assessment of the potential hazard and the time span in which a hazard may exist. Observations of the precise conditions that affect this rate may offer a key to controlling methylation to keep it well below the dangerous background level.

Although the disposal of mercury and other toxic metals into the natural environment can be and is being stopped, dangerous metals are absorbed from contaminated soil and water by plants for years after the original pollution source has been removed. Concentrations of contaminants in soils are often many times greater than they are in water. The metals may accumulate in living plant and animal tissue and thereby be introduced into a food chain that leads to consumption by man.

Short of physically removing the top foot or two of sediment where they are retained, there is no existing method for chemically neutralizing heavy metals in these sediments or for preventing the eventual transformation of mercury into the highly toxic methylmercury form. Preliminary evidence from several laboratories indicates that mercury and its inorganic salts are converted into labile methylmercury and other reactive intermediates by microorganisms in the sediments of aqueous environments.

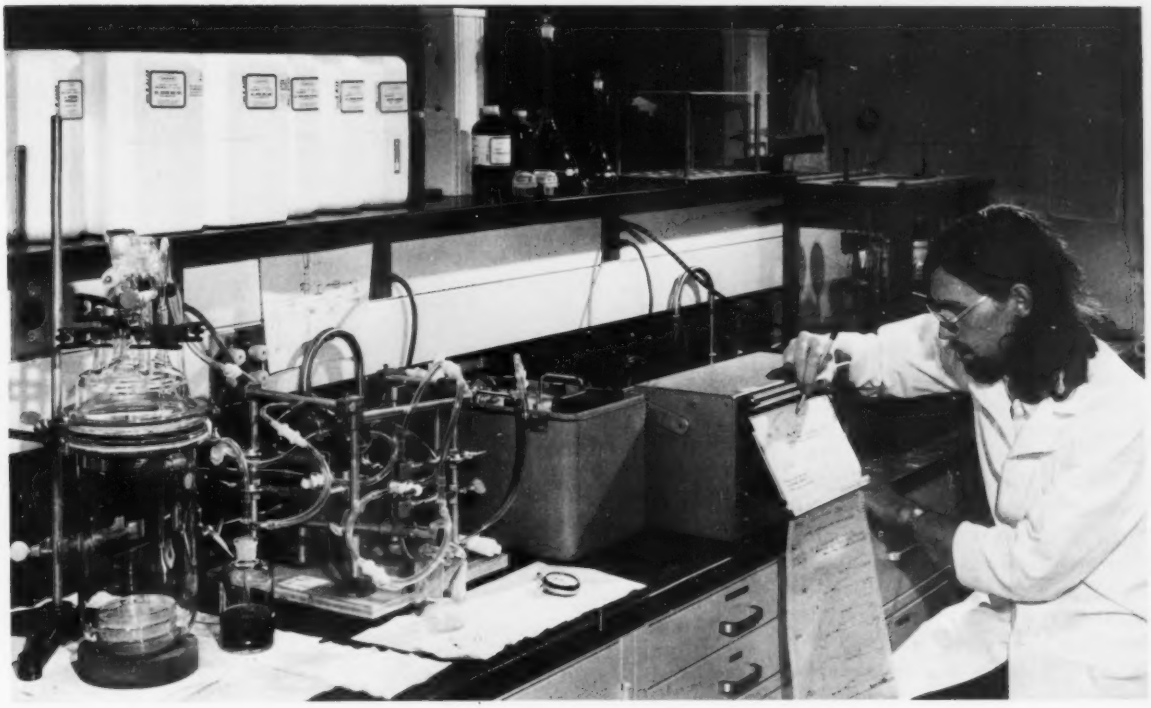
Coordinators of the NBS project, Dr. F. E. Brinckman of the Inorganic Chemistry Section and Dr. W. Iverson of the Corrosion Section, are attacking the problem in several phases, including demonstration of enzymatic and/or nonenzymatic transformations of mercury in the field and characterization of biological and chemical factors influencing rates of transformation of mercury. Initially their main concern is the methylation of mercury in the environment. Later, they hope to apply the experience gained to questions involving other heavy metals.

The first phase of the program involves selection, acquisition, and analysis of field samples of sediment and water which are being analyzed for total mercury and organic mercury. Nuclear magnetic resonance (NMR) and mass spectrometry are being used to characterize the kinds of organic structures bound to metallic or inorganic mercury. In the beginning stages of the project, it is assumed that the occurrence of significant levels of organic mercury in particular field samples may be diagnostic of methylation activity in these materials. Parallel experiments will be designed to detect possible nonbiological methylation pathways.

In connection with the first segment of the program, a cooperative venture between Prof. R. Colwell, University of Maryland, and NBS has permitted rapid examination of mercury-tolerant microorganisms isolated from the Chesapeake Bay. The microorganisms are being studied to determine their influence on mercury transformations. Monitoring mercury concentrations in air circulated over cultures growing on media containing mercury compounds is one technique being used to determine what forms of mercury the microorganisms take up and/or give off. The air is monitored in an open-flow or closed reactor setup by dual-beam atomic absorption spectrophotometry sensitive to the metal at nanogram levels.

Phase I also includes the development of new characterization methods to increase the reliability of future studies. Precise structural and reactivity parameters will be sought for those organomercury compounds used in the program.

If initial work indicates the



Biologist Bill Blair, an NBS guest worker, checks mercury concentrations in air being circulated over a Chesapeake Bay bacterial culture on agar plates containing a mercury compound.

presence of methylmercury in the samples, further studies will be initiated to determine its rate of formation by several methods. An analysis of the sediment for mercury (metallic, inorganic, and organic) will be carried out to establish the base levels for a rate of conversion to methylmercury. Known amounts of mercury and its various compounds will be added to fresh and stored sediments to determine any increase in rate of formation. In addition to these laboratory studies, similar studies *in situ* will be carried out on an isolated portion of the natural environment. Rates of mercury disappearance in the field will be compared to rates of methylmercury formation.

Employing electrochemical polarization and high-resolution NMR techniques, among others, investigations are being made on organic group transfer reactions between mercury and other metals under aqueous solution conditions in order to identify and determine the importance of nonbiological pathways in the formation of specific organometallic compounds. Laboratory evidence already exists to indicate that residual mercury is transformed into harmful labile organoderivatives even at concentrations hostile to the biological system.

In the more general program of biological corrosion and organometal chemistry, a predoctoral research student, Calvin Huey from the University of Maryland, is working on the project as an NBS guest worker. Under the supervision of the two NBS principal scientists, Mr. Huey is screening a wide variety of metals and inorganic compounds for their behavior toward extracellular metabolic products of organisms indicating an ability to corrode and transform metals and their alloys. Depending on the reactions that occur, he will investigate them more thoroughly through kinetic and mechanistic studies.

A good deal of work has already been accomplished at NBS in the design and development of precise handling and control procedures for characterizing volatile metabolic products. Such procedures permit reliable injection or isolation and separation of microquantities of reactive intermediates under restricted atmospheres. Products so obtained may then be characterized by the several advanced methods noted, including infrared, laser-Raman, mass, and nuclear magnetic resonance spectrometry and vapor phase chromatography.

CONFERENCE *Briefs*

1972 CONFERENCE ON PRECISION ELECTROMAGNETIC MEASUREMENTS

Nearly 400 people from 14 countries attended the 1972 Conference on Precision Electromagnetic Measurements (CPEM), held June 26-29 at the Bureau's Boulder, Colo., Laboratories, to hear some of the 92 papers presented at the 4-day meeting.

The conference, which this year defined its goal as "The advancement of electromagnetic measurement science and measurement techniques which are critical to technology and beneficial to society," is cosponsored by the NBS Institute for Basic Standards, the Institute of Electrical and Electronic Engineers (IEEE) Group on Instrumentation and Measurement, and the International Scientific Radio Union (URSI) U.S. National Committee, with the Union Radio-Scientifique Internationale as a cooperating sponsor.

An international session, "Base Standards for Length, Frequency, and Time," proved to be the most popular single session of the conference and brought contributions from Canada, England, France, Japan, Russia, United States, and the International Bureau of Weights and Measures. Other sessions covered the entire electromagnetic frequency spectrum from direct current through microwave and optical frequencies. New to the conference this year were sessions on electrical pulse measurement, radiation safety, electromagnetic-measurement applications, computer-aided design, and optical measurements. Traditional subjects—direct current, low frequency, radio frequency, microwave, and time and frequency—attracted papers describing advances in the state-of-the-art of high-precision measurement and new techniques for high-precision measurement.

Abstracts of papers presented at the 1972 CPEM are available from IEEE, 345 East 47th Street, New York, N.Y. 10017, in a 190-page paper-bound volume, IEEE catalog number 72 CHO 630-4 PREC; price, $15. Selected complete papers were published in the Transactions of the IEEE Group on Instrumentation and Measurement, November 1972 issue.

Since the inception of CPEM in 1958, it has been held biannually at the Boulder Laboratories but in 1974 it will be held in London, England, at the invitation of the Royal Society. The United Kingdom sponsors of the 1974 CPEM are the Royal Society and the Institution of Electrical Engineers (London); cooperating sponsors are the Union Radio-Scientifique Internationale, the Institution of Electronic and Radio Engineers, the National Physical Laboratory, and the Scientific Instrument Manufacturers' Association.

ACM/NBS CONFERENCE ON SIMULATION OF COMPUTER SYSTEMS

Computer simulation is widely used in problem solving. In fact, computers are used to simulate computer systems themselves to solve problems dealing with the design of computer hardware and software configurations.

To focus on the state-of-the-art of computer system simulation, the Bureau, together with the Association for Computing Machinery's Special Interest Group on Simulation (SIGSIM), will sponsor a symposium on the Simulation of Computer Systems, June 19-20, 1973. The meeting will be held at the NBS Gaithersburg, Md., facilities. Leading practitioners in this field of specialization will present papers in the areas of:

- Application of Computer System Simulation
- Simulators in Current Use
- Workload Models
- Simulation Validation
- Outstanding Unresolved Problems

Workshops will provide attendees with a forum for current information and techniques on simulator design, simulation languages, and software and hardware simulation.

The symposium is open to anyone interested in this relatively new development in computer technology. For further information concerning the symposium, or to receive an advanced program, please contact:

General Chairman
Mr. Paul F. Roth
A265 Technology Building
National Bureau of Standards
Washington, D.C. 20234
Tel. (301) 921-3491

For information regarding submission of papers, contact:

Program Chairman
Mr. Philip J. Kiviat
Federal ADP Simulation Center
Hoffman Building
Alexandria, Va. 22314
Tel. (202) 325-0234

SYMPOSIUM TO BE HELD AT NBS

A symposium on Defects and Defect Clusters in Body-Centered-Cubic Metals and Their Alloys will be held at the Bureau, Gaithersburg, Md., August 14-16, 1973.

Sponsored by NBS, the Nuclear Metallurgy Committee of the American Institute of Metallurgical Engineers, and the National Science

continued on page 291

OPTICAL RADIATION NEWS

Optical Radiation News (ORN) is intended to serve as a means of communication among workers in industry, universities, and Government agencies involved in radiometry and photometry. ORN will focus on developments of interest in the laboratory, in the published literature, and at the council table.

CORM REPORT ON PRESSING PROBLEMS

The Council for Optical Radiation Measurements (CORM) recently submitted to NBS its report on needed measurement services. The report, "Pressing Problems and Projected National Needs in Optical Radiation Measurements—A Consensus of Services Desired of NBS," presents the Council's views on urgent problems and relative priorities in the areas of sources, detectors, and techniques, including recommendations on evaluation of commercial standards laboratories and conversion from spectroradiometric to photometric basis.

The Council's study concludes that NBS should:

1. Further develop standard techniques and documentation for both spectral measurements and attenuation.

2. Provide maximum service with its present capability by documenting uncertainties and procedures for existing standards, issuing needed calibrations, and evaluating secondary standards laboratories through a Measurement Assurance Program.

3. Extend its radiometric, photometric, and spectrophotometric standards capability to lower levels, wider spectral regions, and new operating levels specified in the report.

The fundamental problem, as defined in the report, is that the development of essential optical radiation services has not kept pace with the rapid growth in the electro-optics industry, and the lack of needed standards and techniques seriously retards further advances in technology. This situation imposes added costs on industry, places manufacturers in unfavorable competitive positions, inhibits compliance with planned consumer protection legislation, and adversely affects the public in the areas of health, safety, and transportation.

The Council is a body of American industrial, governmental, and university scientists and engineers organized early in 1972 to facilitate the development and industry-wide dissemination of reliable procedures for the measurement of optical radiation. CORM operates as an activity of U.S. Technical Committee 1.2 of the International Commission on Illumination (CIE).

CORRECTION

There were two errors in the table that appeared in the last Optical Radiation News (October Technical News Bulletin, p. 247). The first entry of the left-hand column should have been "spectral radiance", and the second entry "spectral irradiance."

NEW SCALE OF IRRADIANCE

NBS is now reporting all irradiance calibrations above 10 mw/cm² on a new scale, designated E(NBS 72). This scale has been realized using an improved version of an NBS-developed electrically calibrated radiometer,[1] its distinguishing feature being a heater incorporated into the receiving element. The instrument is calibrated by passing an electric current through the heater, and determining the electrical power required to produce the same effect as the radiant power being measured. The uncertainty of the measurement is about 1/2% at 140 mw/cm² and 1% at 30 mw/cm².

An experimental comparison between this new scale and the scale previously maintained on NBS shelf standard lamps indicated a difference of about 2 1/2% at 140 mw/cm² and 1 1/2 to 2% at 30 mw/cm² (values reported for a lamp on the old scale should be increased to bring them into agreement with the new scale). In this comparison, the irradiance of two reflector lamps (1000-watt quartz-halogen lamps mounted in ceramic reflectors, nominal value 140 mw/cm²) and four similar lamps without reflectors (nominal value 30 mw/cm²) was determined on the new scale by the radiometer and compared with the values previously realized by means of a blackbody determination.

The determination of the irradiance of a given lamp was repeatable to about 0.2% in this experiment. The greatest causes of imprecision were the inability to accurately position the lamp relative to the radiometer and possible shifts in

continued on page 291

NSRDS NEWS

The NSRDS was established to make critically evaluated data in the physical sciences available to science and technology on a national basis. The NSRDS is administered and coordinated by the NBS Office of Standard Reference Data.

CRYSTAL STRUCTURE TRANSFORMATIONS IN BINARY HALIDES

Many solids undergo transformations from one crystal structure to another. Studies of such phase transformations are of great value in understanding the nature and properties of solid materials. Although recent literature abounds in information on the phase transformations of solids, it is often difficult to obtain relevant data or references on the transformations of any specific solid. NSRDS-NBS-41, *Crystal Structure Transformations in Binary Halides*[1] (55 cents, SD Catalog No. C13.48:41) by C. N. R. Rao and M. Natarajan, is a critical survey of the data describing crystal structure transformations in binary halides. This compilation provides data on thermodynamic, crystallographic, spectroscopic, and electronic properties for each transformation. Experimental techniques used to obtain the data are named, and comments on the data are included in the tables. The literature is surveyed up to 1970. References have been selected on the basis of their pertinence to the data cited but do not represent all the available literature.

PUBLICATIONS FROM THE RADIATION CHEMISTRY DATA CENTER

Various kinds of data are important in radiation chemistry. The quantities measured first were the observed radiation yields or G values (molecules formed or destroyed per 100 eV). Various indirect methods based on G values have been used to determine yields of transient species and relative rates of reactions. The spectral properties (optical, electron spin resonance) of transients have provided a direct method for their identification, and rates of the very fast reactions of transients occurring in irradiated systems have been measured directly by spectroscopic methods. Conductivity and luminescence methods have also provided means to measure properties of transients and their kinetics. Some reactions which occur in irradiated systems have also been studied by other methods, such as photochemistry, electric discharge, ultrasonics, chemical initiation, electron impact, etc.

The data of radiation chemistry are voluminous; thousands of systems have been investigated. As a result, there are certain collections, e.g., rate constants of particular types of reactions or certain properties of transients, for which tabulations of the data are considered essential, but for which critical assessment of each value is impossible. On the other hand, certain systems and properties have been studied so extensively that critical examination of these data is desirable and timely.

The Radiation Chemistry Data Center, University of Notre Dame, one of the data centers in the National Standard Reference Data System, has inaugurated a new series of data publications whose aim is to compile, evaluate, and present the numerical results on processes occurring in systems which have been subjected to ionizing radiation. The emphasis in these publications is on the data of radiation chemistry, but other pertinent data are included. Authors of this series of data publications have been asked to evaluate the extent to which the data can be critically assessed, to describe their criteria for evaluation, and to designate preferred values whenever possible.

In the first publication of this new series, the nature and chemical properties of solvated electrons in selected solvent media are the subject of extensive study. NSRDS-NBS-42, *Selected Specific Rates of Reactions of the Solvated Electron in Alcohols*[1] (30 cents, SD Catalog No. C13.48:42) by Edgar Watson, Jr., and Sathyabhama Roy, is a compilation of rate constants and

Arrhenius parameters and has been prepared in order to consolidate the information available in the literature. These data are presented as reported without critical evaluation. An attempt has been made to include all rate data which have been reported for alcohols. Duplication of references has been avoided in cases where it was apparent that two or more publications reported the same experimental results. Rates of reactions of e_s^- with solvent and solute molecules, ions, and transients in alcohol solutions are presented in the table. Arrhenius parameters are tabulated for some reactions.

RADIATION CHEMISTRY DATA CENTER CUMULATIVE INDEX AND THESAURUS

The third number of the *Index and Cumulative List of Papers on Radiation Chemistry* covering the period January through June 1972 has been issued by the University of Notre Dame Radiation Chemistry Data Center. The 27,880 references were obtained by scanning 40 appropriate current journals, chemical abstracts, and nuclear abstracts. References are grouped into the following categories: radiation chemistry, polymers, biological systems, hot-atom chemistry, ESR, luminescence, photochemistry, theoretical studies, and miscellaneous.

The Radiation Chemistry Data Center has also revised its *Thesaurus for Radiation Chemistry*. The Thesaurus is a list of keywords which have been developed for describing papers within its field of interest. The keyword list in the Thesaurus is followed by a formula list. New terms are added to the Thesaurus as the occasion arises.

The Cumulative Index may be ordered from the National Technical Information Service, Springfield, Va. 22151 for the price of $6 per issue. The price of the Thesaurus is $3. Previous numbers of the Index and Cumulative List of Papers are also available. Order the first number covering the period January through June 1971 as COM-71-01103. The second number order as COM-72-10266 and the third as COM-72-10621. Order the Thesaurus as COO-38-621 (revised August 1972).

TWO CRITICAL REVIEWS PUBLISHED

The latest in the series of critical reviews on atomic and molecular collisional processes published by Wiley-Interscience under the sponsorship of the Atomic and Molecular Processes Information Center, Oak Ridge, Tenn., are *Excitation in Heavy Particle Collisions*[2] by E. W. Thomas and *Dissociation in Heavy Particle Collisions*[2] by Gordon W. McClure and James M. Peek.

Excitation in Heavy Particle Collisions is a critical review and evaluation on the formation of excited atoms induced in collisions between atomic and molecular systems. The book provides comprehensive and easily accessible reference to the reliable and current data available on some 147 different pairs of colliding particles. The full world literature on this subject has been covered by the author. The diverse results reported are unified by the author in three steps. First, the philosophy of the experimental techniques is considered. The author formulates criteria needed for an experiment to be judged a valid and accurate measurement of the stated physical quantity. Second, the data are cataloged and collected. Finally, experimental techniques are examined against the established criteria, with the author identifying the deficiencies that exist in particular studies. Special features of this critical compilation include:

1. A complete bibliography to all work under discussion;

2. An appendix of the most recent data up to the time of publication;

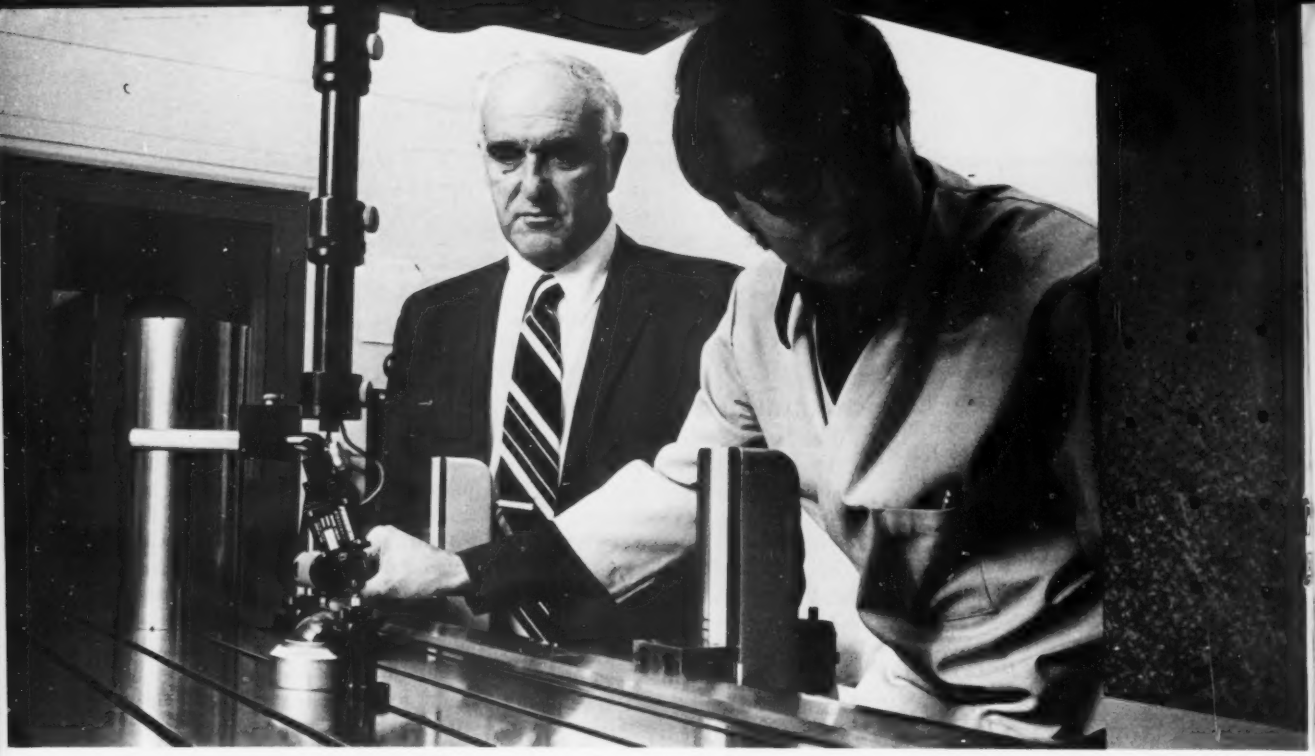
3. A summary index to collisional excitation mechanisms listing all processes that have been studied with references to the location of detailed discussions in the main body of the text; and

4. Tables reproducing the evaluated data.

Dissociation in Heavy Particle Collisions is a critical review of the published information concerned with the dissociation of molecules undergoing single collisions with heavy particles. The material falls into three parts. Chapter 1 provides a general introduction to the subject of dissociative collisions. Chapters 2 through 6 discuss the experimental approach used to obtain dissociation cross-section data, and chapter 7, the final chapter, deals with the theoretical approach employed to obtain dissociation data. The experimental portion of the book, part 1, analyzes the experimental methods of investigation. It presents a comprehensive tabular guide to the literature on experimental studies in which the sources are listed according to the pair of colliding particles, energy of collidants, dissociation fragments observed, and properties of the dissociation fragments measured such as energy and angular distribution.

In part 2, a systematic list of criteria for a well-defined measurement is developed, providing a means to evaluate the research data and serving as a checklist for investigators planning new measurements. In addition, a summary of the most significant qualitative findings is presented with references to the original literature on which the findings are based. In the theoretical chapter, part 3, the notation and theoretical models are introduced. Then, considerable attention is given to the classical-binary and firstborn theories. A major portion of the theoretical section is concerned with several subsidiary

continued on page 292



Dr. Ernest Ambler, Director of the Institute for Basic Standards, looks on as Nelson Norden positions the contact probe during an acceptance test.

UNIFIED 3-DIMENSIONAL MEASUR

The science of measurement does not stand isolated from the mundane world. Measurements are only made to satisfy external needs and the science is thereby shaped by these needs. Dimensional technology thus reflects to a large extent the particular needs of the precision metal-working industries. In the last few years this industry, or at least the high technology sector of it, has been revolutionized by the large scale introduction of numerically controlled machine tools. These NC machines, under control of punched paper tape or increasingly under direct computer control, work directly from the designers conception of the product expressed in numbers, sizes, angles, etc., to the finished piece without human intervention. The result is increased precision and production of a better product at less cost.

The impact on dimensional metrology of this change in production technique is profound. The workhorses of current practice, gage blocks, surface plates, micrometer calipers and master gears, master threads, etc., are useful only in the hands of skilled humans. Not only are the humans increasingly absent from the production process but the breaks in the process during transfer from one single-purpose machine to the next, during which measurements are usually made, no longer exist. Yet the need for uniformity and dimensional control called for by interchangeability of parts remains.

To meet its responsibilities under these changed circumstances, the Optical Physics Division embarked on a Unified 3-Dimensional Measurement Program. This program of machine oriented dimensional metrology is designed to meet the needs of machine oriented production. It recognizes that since no intermediate steps exist in the process where simple measurement of single parameters can be made, every calibration will be most likely of a complex 3-dimensional finished piece. It also recognizes that since the NC machines are flexible and multipurpose, so must be the measuring system. No longer, for example, can all gears be referred to a master gear while all threads are referred to a master thread with no tie between them; both threads and gears must be referred to a more general master. Ideally, this general master would be the International Meter (SI).

The implementation of this program centers around a new 3-dimensional measurement facility. The Bureau has procured a three-

Unloading the new 3-D machine from the delivery truck.

Edgar Erber uses a remote control panel to position the contact probe. Eventually this function will be under computer control.

SUREMENT PROGRAM

axis measuring machine built to state-of-the-art specifications. This machine, when installed in the proper environment which is being prepared for it, has the capability of measuring any complex shape fitting in a volume of $48 \times 24 \times 12$ inches. Its accuracy, derived from precision screws and carefully hand-worked ways and slides, is better than 0.0001 inch over most of its working volume. It can detect a difference in length of 0.00001 inch.

This machine, under human control, is capable of measuring the test objects used to calibrate and verify the most complex NC machines. However, this performance represents only a first phase of the full solution, for there is still a human involved. He is expensive, doesn't speak the language that was used to describe the piece to the NC machine, gets tired, makes mistakes, and only works an 8-hour day less coffee breaks.

Phase II is to place the machine under the control of a dedicated mini-computer which can accept the same description of the piece as the NC machine and shares its tireless devotion to what to humans are not very exciting activities. This phase of the program is well underway with the computer procured and the basic software (computer educational material) sketched out. The necessary interfaces, which are the computer's "hands" to control the machine, are under construction within the Optical Physics Division. The marriage between the computer and the measuring machine is scheduled for early 1973.

Getting the human out of the system is not an unqualified advantage, since the human senses of sight and touch are unparalleled. To make up for this loss, a parallel effort is underway to develop sensors whose outputs the computer can use to make real-time (instantaneous) decisions. The first of these, a sensitive detector of a surface and very short range range-finder, has been developed,[1] and others are being worked on.

When this phase is complete, NBS will have a unique 3-dimensional measuring machine under full computer control, with which to accomplish the calibrations needed by the new processes and, perhaps more important, to understand the new metrological problems and develop satisfactory solutions to them.

Even then the situation is not satisfactory. In a sense, we will have distilled down the present set of master gage blocks, master

threads, gears, balls, involutes, etc., into one machine. But the absolute accuracy—the relation of the object size to the International Meter (SI)—will depend on the accuracy of the calibration and geometry of the basic measuring machine and on its long-term stability. For almost all purposes, this is demonstrably good enough, but there remain some needs at the peak of high technology where this will not suffice.

To fulfill our responsibilities to this segment of the national measurement system, we must move closer to the SI unit. This phase, already underway, makes use of the newly developed stabilized laser interferometers. These devices refer all lengths to a laser which can be directly and, if desired, simultaneously compared to the SI unit. Indeed, it is foreseen that in time such a laser will define the SI unit. The problem of substituting such a system for the currently used precision screws is simply solved but, unfortunately, not sufficient. The largest source of inaccuracies comes not from the screws but from imperfections in the basic machine geometry and from distortions to this geometry as the (heavy) workpiece and support move. Studies are well underway of various schemes to measure and/or correct for these errors. It is anticipated that one of these will be implemented by early 1974.

In a few years NBS will be in a position to satisfy the most sophisticated needs of the precision industries, providing higher accuracy at less cost. In the process of achieving this capability we will have built up a competence in and an understanding of the nature of the demands that will be made on us in the future.

[1] Simpson, J. A., Use of a microscope as a noncontacting microdisplacement device, Rev. Sci. Instr. **42**, 1378 (1971).

Referee Method for Determining Calcium in Serum

A physician's decision whether or not to operate is frequently based on clinical tests of calcium in serum. An excessive amount of calcium—hypercalcemia, when supported by other clinical evidence, is often indicative of hyperparathyroidism, a condition that may require immediate surgery. Therefore, the rapid and accurate analysis of calcium in serum is of vital importance.

A referee method for the accurate determination of calcium in serum and/or solutions containing physiological amounts of sodium and potassium has been tested and validated. A first in clinical chemistry, this referee method was recently developed by experts from the field of clinical chemistry, eight cooperating clinical laboratories, and NBS.[1]

A referee method is a measurement technique designed to determine the concentration or properties of a material to a well-defined accuracy level. By following exactly the referee method for determining calcium, the "true or absolute" value of calcium in solution or serum can be determined within ±2 percent in the concentration range from 3 to 6 milliequivalents calcium per liter of sample, the levels usually found in the body.

Using this referee method, clinical chemists can check the accuracy and validity of measurements made using their routine procedures. From such comparisons, they can work to eliminate, or at least define, any biases or inaccuracies that may exist in their techniques.

The primary uses of this referee method are:

*To establish the absolute value of calcium in control or pooled sera;

*To establish the validity of calcium values given in various clinical kits;

*To establish and maintain the quality of calcium reference materials, kits, control sera, etc.; and

*To ascertain the accuracy of many field methods for calcium.

Based on an atomic absorption spectrometric technique developed by Pybus, et al.,[2] a series of five exercises were conducted by the participating laboratories. In the first two exercises, replicates of aqueous solutions based on calcium carbonate (Standard Reference Material 915)[3] were distributed to the laboratories for measurement. Pooled sera of varying calcium concentrations were used in the remaining exercises. Before the solutions were distributed to the laboratories, their calcium values were accurately and independently measured at NBS using isotope-dilution mass spectrometry.

In the course of the development work, the candidate procedure was modified three times to eliminate observed systematic errors. The calcium values determined in the final exercise using the referee atomic absorption spectrometric method correspond closely to those made using isotope-dilution mass spectrometry.

[1] Cali, J. P., Mandel, J., Moore, L., and Young, D. S., A Referee Method for the Determination of Calcium in Serum, NBS Spec. Pub. 260-36, 121 pp. (May 1972). Order by SD Catalog No. C13.10:260-36 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Price $1.25.

[2] Pybus, J., Feldman, F. J., and Bowers, G. N., Jr., Measurement of total calcium in serum by atomic absorption spectrophotometry, with use of a strontium internal reference, Clin. Chem. **16**, 998-1007 (1970).

[3] Information on this and other Standard Reference Materials is available from the Office of Standard Reference Materials, National Bureau of Standards, Washington, D.C. 20234.

BRIEFS *continued*

Foundation, the symposium will provide an open forum for the latest data on defects resulting from neutron and charged-particle irradiations and from quenching.

Underscoring the need for and timeliness of this conference are the facts that b.c.c. refractory metals are strong candidates as first-wall materials for fusion reactors as well as fuel-cladding materials for fast breeder reactors. Increasing concern among reactor planners and designers has been raised by recent studies showing that irradiation can cause void formations which swell and weaken the affected materials. Design modifications, which would have important economic ramifications, will be necessary for reactors operating at high temperatures.

Defects and defect clusters caused by quenching have been recognized for some time. Quenching studies provide valuable supplemental information on the behavior of b.c.c. metals with defects.

Tentative plans call for approximately 40 internationally known experts to speak on various aspects of neutron irradiations, charged-particle irradiation, quenching, and general theory. Floor discussion will be encouraged.

For further information on this symposium, contact:

Prof. R. J. Arsenault
Department of Chemical Engineering
University of Maryland
College Park, Maryland 20740

OR NEWS *continued*

filament position during relighting of the lamp. This procedure is expected to be greatly improved through use of a kinematically designed lamp holder[2] and an improved lamp design.

PHOTOMETRIC CALIBRATION PROCEDURES

NBS Technical Note 594-3, *Photometric Calibration Procedures*, is in process of publication. Authored by Velma I. Burns and Donald A. McSparron, this paper is the third in the series on Optical Radiation Measurements.

This Technical Note contains detailed descriptions of the procedures and equipment used at NBS to perform calibrations of luminous intensity (candela), geometrically total luminous flux (lumen), and color temperature, identical to the descriptions now accompanying such calibrations. Lamp standards of luminous intensity and of color temperature calibrated in accordance with these procedures are now routinely available as "off the shelf" items, due to the revised calibration policy of the Optical Radiation Section (NBS Technical News Bulletin, June 1972). The procedure for luminous flux calibrations covered in this report was utilized in a recent large test involving 180 standards for nine laboratories. Requests for individual calibrations of luminous flux will be handled on an individual basis, due to low demand, but such tests will be performed in a manner very similar to this procedure. Prices and ordering information may be obtained from NBS Special Publication 250 (Measurement Users Bulletin No. 4).

In many cases, the presently available uncertainty information on these calibrations is inadequate or incomplete. In this Technical Note, an attempt is made to present the available information and point out its limitations. Major research efforts are currently being devoted to improving these procedures and documenting their uncertainties, and this information will be reported in the Technical Note series and incorporated into the routine calibrations as it becomes available.

LABORATORY INTERCOMPARISONS TO BE ALTERED

A program to permit commercial calibration laboratories to demonstrate their capabilities in selected optical radiation measurements, through intercomparisons with NBS, was announced in the September 1972 issue of the NBS Technical News Bulletin. Subsequently, many of these laboratories indicated that the program appeared to be too expensive in both man-hours and direct cost, while several large in-house industrial laboratories indicated keen interest in participating. Since the program as originally proposed now seems unworkable, NBS is seeking input from the optical radiation community on the form such intercomparisons should take. Presumably, participation no longer would be limited, nor would the program be tailored to the needs of the public issuance laboratories. Interested parties should submit their comments in writing to:

Donald McSparron
Optical Radiation Section
Room B312, Metrology Building
National Bureau of Standards
Washington, D.C. 20234
(301) 921-2113

Needed information includes the program goal, specific benefit to participant, acceptable cost and frequency of subsequent intercomparisons, and physical quantity to be compared.

[1] Geist, J., Fundamental Principles of Absolute Radiometry and the Philosophy of this NBS Program (1968 to 1971), Nat. Bur. Stand. (U.S.), Tech. Note 594-1 (1972). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $2. Use SD Catalog No. C13.46:594-1.

[2] Zalewski, E. F., Schaefer, A. R., Mahan, K., and McSparron, D. A., Photometric Instrumentation and Research (1970 to 1971), Nat. Bur. Stand. (U.S.), Tech. Note 594-2 (1972). Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for 50 cents.

NSRDS *continued*

approximations peculiar to the treatment of dissociative collisions. Tables supply a list of papers devoted to a given collisional system, an identification of the theoretical framework used in each paper, and a list of approximations made in addition to the assumed theoretical framework.

TWO COMPILATIONS FROM PARTICLE DATA GROUP

NSRDS-LBL-58, *$\bar{N}N$ and $\bar{N}D$ Interactions—A Compilation*, May 1972, by James E. Enstrom et al., is a compilation of data from 181 papers reporting $\bar{p}p$, $\bar{p}n$, $\bar{p}d$, $\bar{n}p$, $\bar{n}n$, and $\bar{n}d$ reactions in flight for beam momenta up to 50 GeV/c. The compilation displays, as a function of incident momentum, total and channel cross sections, elastic and two-body inelastic differential cross sections, and polarization in elastic scattering, as well as fits to the elastic differential cross sections. Also provided are indexes to the papers, as well as a complete listing of the selected data. The approximate cutoff date for the literature in this compilation was September 1971.

NSRDS-LBL-80, *A Compilation of Data on Inclusive Reactions*, August 1972, by M. E. Law et al., is a relatively self-contained compilation of the most relevant graphs and references on multiparticle inclusive reactions. In addition to published data, the authors included more recent material appearing either in preprint form or in review articles. The compilation is organized in looseleaf form so that, as new data become available, pages can be added or replaced. The compilation consists mainly of the published data graphs which have been blown up to fit neatly onto a standard 8 1/2 in.×11 in. page. As an aid to the reader, the authors have superimposed grids on these plots so that it will be easier to read points off the graphs. A bibliography is also provided to supplement the information contained in the graphs. The single particle spectra $ab \rightarrow cX$ are collected according to the nature of the beam and target: pp, p-Nucleus, $\bar{p}p$, $K\pm p$, $\pi\pm p$, ep (μp), γp. Within each category, plots are arranged in order of increasing beam momentum. A set of references follows each section; these references include some papers from which no graphs were reproduced. Sections on comparative plots and two-body correlations are also provided. NSRDS-LBL-80 includes a review article by J. Kasman on the kinematics and phenomenology of inclusive cross sections and multiparticles reactions. Both NSRDS-LBL-58 and NSRDS-LBL-80 may be obtained on request from the Berkeley Particle Data Center, Lawrence Radiation Laboratory, Berkeley, Calif. 94720.

[1] Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for the price indicated.

[2] Available from Wiley-Interscience, 605 Third Avenue, New York, N.Y. 10016. The price for *Excitation in Heavy Particle Collisions* is $22.50. The price for *Dissociation in Heavy Particle Collisions* is $13.95.

TOPOGRAFINER *continued*

a constant current is passed through the emitter, the electric field strength at the emitter surface is fixed according to the Fowler-Nordheim (F-N) equation. Laplace's equation then predicts the field strength everywhere between the emitter and the surface, thus determining the relationship between the emitter-to-surface spacing (emitter spacing) and the emitter-to-surface voltage (emitter voltage).

In the topografiner, the voltage between the emitter and the surface is amplified and applied to a piezoelectric ceramic element on which the emitter is mounted. This forms the servo system that keeps the emitter a constant distance above the surface. The piezo voltage corresponds to the altitude of the surface. The topografiner is equipped with two scanning piezo elements that sweep the emitter over the specimen surface in a pattern that can be used to generate a topographic map of the surface. The instrument actually scans a series of closely spaced profiles of the surface and plots them to give a three-dimensional representation of the surface microtopography.

A number of parameters determine the basic sensitivity of the topografiner. A relationship has been found that connects the minimum detectable displacement for an emitter carrying a constant current to the emitter spacing, emitter radius and the minimum detectable change in emitter voltage. For a typical emitter spacing of 200 Å (2×10^{-6} cm), the theoretical minimum detectable displacement is 0.2 Å (2×10^{-9} cm), regardless of the emitter radius. In order to remove the effects of ambient gas on system noise when a tungsten emitter is used, it has been necessary to employ a vacuum of about 4×10^{-10} torr (1 torr $= 1.33\times10^{2}$ N/m^2) for quiet operation. An investigation is in progress to find an emitter that remains sharp and is less sensitive to ambient gas.

The elements of the servo loop, which keeps the emitter a constant distance from the surface, include a constant-current power supply, a 2,000-volt operational amplifier, an RC element consisting of the piezo capacitance and an interchangeable resistance, the piezo itself, and the field-emission probe device.

[1] Young, R., Ward, J., and Scire, F., The topografiner: an instrument for measuring surface microtopography, Rev. Sci. Inst. **43**, No. 7, 999-1011 (July 1972).

[2] Young, R. D., The field emission ultramicrometer, Rev. Sci. Inst. **37**, 275 (1966).

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INDEX TO THE

Technical News Bulletin

Vol. 56, 1972

A–B

Absolute Measurement of Viscosity (May) 102
Alloy Preparation Laboratory (Aug.) 182
Atomic Clocks: First Class International Travelers (Oct.) 233
Biosphere, Cycle of Metals in (Dec.) 282
Bolovac Eyes Industrial Market (Feb.) 37
Bolovac Reassessed (Sept.) 227
Bovine Liver and Trace Element Analysis (Apr.) 88
Breakthrough in Measurement Science (Apr.) 75
Buildings, NBS Study to Determine Wind Effects on (June) 142

C–D

Calcium in Serum, Referee Method for Determining (Dec.) 290
Captions Aid Deaf TV Viewers (June) 133
Center for Building Technology Created (Oct.) 240
CENTER FOR COMPUTER SCIENCES AND TECHNOLOGY NEWS
- Calendar Date Standards Approved (Apr.) 76
- CCST and its Program (Feb.) 30
- Conference on Automation Technology for the Retail Industry (Aug.) 196
- Data Codes Registration (Mar.) 68
- Effects of Magnetic Fields on Computer Magnetic Storage Media (June) 150
- Federal COBOL Standard Established (Apr.) 76
- FIPS Pub 12 Revised (Mar.) 68
- FIPS Task Group on Optical Character Recognition (May) 122
- Government-Wide COBOL Validation Services Planned (Mar.) 55
- Guidelines for Describing Data Interchange Formats (Mar.) 68
- Minicomputer Symposium Held at NBS (May) 120
- NBS Connected to ARPA Network (Mar.) 54
- Workshop on Display Terminals and Wired Cities (Apr.) 77

Changing Priorities in Today's Technology (May) 106
Channel Capacity of the Ear and Speech Intelligibility (June) 144
Color, Horse of Another (Nov.) 256
Computer Chief Wins Federal Woman's Award (May) 123
Computer Research and Development, Proposed Legislation for (Sept.) 216
Computer Technology, NBS and the Development of (July) 161
CONFERENCES
- Analytical Chemistry: Key to Progress on National Problems (Nov.) 264
- Conference on Precision Electromagnetic Measurements (Jan.) 21
- Conference on Simulation of Computer Systems (Dec.) 284
- Menzel Symposium (Jan.) 21
- National Conference on Roofing Technology (Nov.) 264
- Precision Electromagnetic Measurements Conference, 1972 (Dec.) 284
- Scintillation and Semiconductor Counter Symposium (June) 148
- Sixth Materials Research Symposium Announced (July) 172
- Symposium on Defects and Defects Cluster in Body-Centered-Cubic Metals and Their Alloys to be Held (Dec.) 284
- Workshop for Rocky Mountain Region (Jan.) 20

Consumer Guide on Hearing and Hearing Aids (Apr.) 83
Court Reporting Systems Compared (Aug.) 194
Cycle of Metals in the Biosphere (Dec.) 282
Deaf TV Viewers, Captions Aid (June) 133
Density, Precision Measurement of (Feb.) 28
DeSimone Receives Civil Service League Award (May) 116
Dimensional Accuracy in Manufacturing (Feb.) 35
Dynamic Pressure Transducer Calibrator (May) 110

E–F–G

Earthquake Detector, Gold Mine Houses World's most Sensitive (June) 131
Earthquake, Report on the San Fernando (May) 99
Environment for Innovation (Apr.) 80
Evaluating Nuclear Radiation Detectors (Apr.) 84
Fire Engine Replacement, Scheduled (Nov.) 262
Footprints, Identification of Patients by (Apr.) 90
Foreign Computer Technology, NBS helps Guide (Oct.) 243
Gas Standards, Microbubble Basis for (Aug.) 181
Gold Mine Houses World's Most Sensitive Earthquake Detector (June) 131
Gypsum Industry Sponsors Research Associate (Sept.) 219

H–I–J–K

Hearing and Hearing Aids (Apr.) 83
High Accuracy Spectrophotometry (July) 166
High-Precision, Rotary-Vane Attenuator (July) 169
High Pressure Mass Spectrometric System (Jan.) 6
High Velocity, Ultrasonic Simulation of (Feb.) 41
High Voltage Measurements, New Techniques for (Sept.) 207
Highly Accurate Spectrophotometer Developed (Oct.) 238
Horse of Another Color (Nov.) 256
Houses, NBS Study to Determine Wind Effects on (June) 142
Identification of Patients by Footprints (Apr.) 90
Improved Method for Lens Testing (Aug.) 188
Improved Thermocouple Tables (Sept.) 224
Improved Version of OMNITAB (Sept.) 226
Infrared Radiation, Plastic Material Senses (Mar.) 52
Innovation, Environment for (Apr.) 80
Intercomparisons, Photometric and Radiometric (Sept.) 209
Interferometer Developed to Measure Sphere and Cylinder Diameters (Jan.) 4
International Standardization (Oct.) 236
Internationalizing Magnetic Tape Standards (July) 174
Interstellar Molecule Detection (Feb.) 27
Josephson Effect, NBS to Maintain Legal Volt Using (July) 159
Kilowatt Hour, Program to Improve Transfer of (Jan.) 3

L–M

Laboratory Work Aids Interstellar Molecule Detection (Feb.) 27
Laser Beam Tests Pressure Transducers (July) 170
Laser Chemistry Studies, New Technique for (Nov.) 271
Law Enforcement Standards, Modern (June) 139
Lens Testing, Improved Method for (Aug.) 188
Lightning Arresters (Mar.) 56
LNG Study, Research Grant for (Nov.) 259
Magnetic Tape, New Test for (Mar.) 67
Magnetic Tape Standards, Internationalizing (July) 174
Mass Spectrometric System, High Pressure (Jan.) 6
Measurement, Role and Value of (Sept.) 216
Measurement Science, Breakthrough in (Apr.) 75
Measuring Diameters of Small-Bore Metal Tubing (Jan.) 12
Measuring Dynamic Loads in a Fatigue Machine (May) 118
Measuring Mechanical Compliance of Metal Specimens (Apr.) 78
Mercury Pollution, New Standard helps Fight (May) 122
Metal Specimens, Measuring Mechanical Compliance of (Apr.) 78
Methane Properties Studied (Mar.) 59
Metric America Bill Sent to Congress (May) 117
Metric Conversion Card (Oct.) 232
Microbubble Basis for Gas Standards (Aug.) 181
Millimeter Wave Calibration Service, NBS Inaugurates (May) 112
Modern Law Enforcement Standards (June) 139
Mole Adopted as International System Base Unit (Feb.) 42

N

National Needs in Pressure and Temperature (Aug.) 187
NATIONAL STANDARD REFERENCE DATA SYSTEM
A Guide to Procedures for the Publication of Thermodynamic Data (Feb.) 39
A Multiplet Table of Astrophysical Interest (Aug.) 184
Activation Analysis Bibliography (Jan.) 16
Atomic Energy Levels (June) 147
Berkeley Particle Center Publishes Two NSRDS Compilations (Oct.) 245
Bibliography on Atomic Transition Probabilities (Jan.) 15
Bibliography on Chemical Kinetics in the C-O-S and H-N-O-S Systems (Aug.) 185
CATCH Tables (July) 165
Chemical Kinetics in the C-O-S and H-N-O-S Systems (Nov.) 267
Class II Spectra (Oct.) 245
Coblentz Society Infrared Reference Spectra (Apr.) 92
Conference on Critical Evaluation of Chemical and Physical Structural Information (Oct.) 244
Crystal Structure Transformations in Binary Halides (Dec.) 286
Cumulative Index to Papers on Radiation Chemistry (Feb.) 40
Cumulative Index to Papers on Radiation Chemistry (June) 147
Data Center on Spectral Line Shapes and Shifts (Aug.) 184
First Issue of Journal of Physical and Chemical Data Published (May) 124
Gas Phase Reactions of N_2; O_2; and Nitrogen Oxides (Jan.) 15
Heavy-Atom Kinetic Isotope Effects (Nov.) 267
Importance of Critically Evaluated Numerical Data (Jan.) 14
International Association for the Advancement of High-Pressure Science and Technology (Apr.) 93
Mössbauer Effect Data Center (July) 164
NATIONAL STANDARD REFERENCE DATA SYSTEM—Continued
NBS Alloy Data Center Author Index (Jan.) 15
NSRDS Publications List (Aug.) 184
OMNITAB II User's Reference Manual (Feb.) 40
On-Line File Management at JILA (Nov.) 265
Properties of Selected Superconductive Materials (Sept.) 223
Publications from the Radiation Chemistry Data Center (Dec.) 286
Radiation Chemistry Data Center (Mar.) 64
Rate Constants of Gas Phase Reactions (Sept.) 223
Recommendations for Compilation of Critically Evaluated Data (Mar.) 65
Recommendations for the Reporting of Experimental Measurements (Mar.) 66
Rensselaer Molten Salts Data Center (June) 146
Second Issue of Journal of Physical and Chemical Data (Sept.) 222
Selected Values of Chemical Thermodynamic Properties (Feb.) 39
Standard X-Ray Diffraction Powder Patterns (Apr.) 93
Structural Data on Elements and Intermetallic Phases (July) 165
Symposium on Applications of Nuclear Data (Oct.) 245
Tables of Molecular Vibrational Frequencies (Oct.) 244
Theory of Change Exchange (July) 164
Thermal Conductivity of Gases (Mar.) 65
Thermophysical Properties of Parahydrogen (Oct.) 249
Translation from Russian of Properties of Liquid and Solid H_2; (Apr.) 93
Translation of Viscosity of Gases and Gas Mixtures (Feb.) 41
Two Compilations from Particle Data Group (Dec.) 286
Two Critical Reviews Published (Dec.) 286
NBS and the Development of Computer Technology (July) 161
NBS helps Guide Foreign Computer Technology (Oct.) 243
NBS Inaugurates Millimeter Wave Calibration Service (May) 112
NBS to Maintain Legal Volt Using the AC Josephson Effect (July) 159
NBS 1971—An Overview (Jan.) 8
NBS Study to Determine Wind Effects on Houses (June) 142
NBS to Study Impact of ASCII as a Federal Standard (Dec.) 280
Neutron Energy Deposition in Tissue (Nov.) 270
New Center for Building Technology Created (Oct.) 240
New Environmental Radioactive Pollutant Standards (Oct.) 231
New Facilities for Plumbing Research (Mar.) 58
New Standard helps Fight Mercury Pollution (May) 122
New Technique Developed for Laser Chemistry Studies (Nov.) 271
New Techniques for High Voltage Measurements (Sept.) 207
New Test for Magnetic Tape (Mar.) 67
1972 Precision Measurement Grants (Nov.) 261
Northeast Corridor, Transportation in (Aug.) 186

O–P

Office of Housing Technology Established (Aug.) 193
OMNITAB, Improved Version of (Sept.) 226
OPTICAL RADIATION NEWS
A Radiometric Bibliography (Feb.) 46
Absolute Radiometry (Aug.) 198
CIE News (Oct.) 247
Conference on Radiometry and Photometry (Feb.) 44
CORM Action (Oct.) 247
CORM Report on Pressing Problems (Dec.) 285
Council on Optical Radiation Measurement Organized (Apr.) 87
Dictionary for Radiometry (Oct.) 246
Laboratory Intercomparisons to be Altered (Dec.) 285
New Scale of Irradiance (Dec.) 285
Photometric Calibration Procedures (Dec.) 285
Photometric Instrumentation and Research (Oct.) 246
Prices for New Calibrations (Oct.) 247
Revised Calibration Policy for Radiometry and Photometry (June) 152
Second CORM Meeting (Aug.) 199
Technical Note Series for Optical Radiation Measurements (June) 155
Uncertainty and Luminous Intensity (Feb.) 44
Photometric and Radiometric Comparisons (Sept.) 209
Physicist Honored (Nov.) 261
Physiological Uses, Titanium Studied for (Aug.) 190
Plastic Material Senses Infrared Radiation (Mar.) 52
Plumbing Research, New Facilities for (Mar.) 58
Police Body Armor, Standard for (Nov.) 258
Pollutant Standards, New Environmental Radioactive (Oct.) 231
Pollution Monitor Developed, Sulfur Dioxide (Oct.) 234
Pollution, New Standard helps Fight Mercury (May) 122
Precision Measurement of Density (Feb.) 28
Precision Measurement Grants (Nov.) 261
Preparing Ultrapure Reagents (May) 104
Pressure Calibration Courses Offered (Aug.) 185
Pressure Gage Service, New (Dec.) 278
Pressure Transducer Calibrator, Dynamic (May) 110
Pressure Transducers, Laser Beam Tests (July) 170
Program to Improve Transfer of Kilowatt-Hour (Jan.) 3
Proposed Legislation for Computer Research and Development (Sept.) 210

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PUBLICATIONS

Consumer Guide on Preservation of Books (June) ... 149
Cyclic Designs (July) ... 172
International System of Units (July) ... 172
Precision Measurement and Calibration—Frequency and Time (Nov.) ... 264
Precision Measurement and Fundamental Constants (Jan.) ... 21

R

Radiation Measurements, Radiochromic Dye Films Applied to (June) ... 134
Radiochromic Dye Films Applied to Radiation Measurements (June) ... 134
Radiopharmaceuticals (Jan.) ... 18
Reagents, Preparing Ultrapure (May) ... 104
Referee Method for Determining Calcium in Serum (Dec.) ... 290
Report on the San Fernando Earthquake (May) ... 99
Research Associate, Gypsum Industry Sponsors (Sept.) ... 219
Research Grant for LNG Study (Nov.) ... 259
Role and Value of Measurement (Sept.) ... 216
Rotary-Vane Attenuator, High Precision (July) ... 169

S

Safer Matches and Lighters, Study Indicates Need for (Sept.) ... 215
Scanning Electron Microscope Facility (Mar.) ... 60
Scanning Thermal Detector Developed (Dec.) ... 277
Scheduled Fire Engine Replacement (Nov.) ... 262
Sea, Search and Rescue Operations at (Aug.) ... 179
Search and Rescue Operations at Sea (Aug.) ... 179
Soviet Metrology Team Visits NBS (May) ... 101
Spectrophotometer Developed (Oct.) ... 238
Spectrophotometry, High Accuracy (July) ... 166
Speech Intelligibility, Channel Capacity of the Ear and (June) ... 144
Staff Members Edit Special IEEE Issue (Nov.) ... 260
Standard for Police Body Armor (Nov.) ... 258

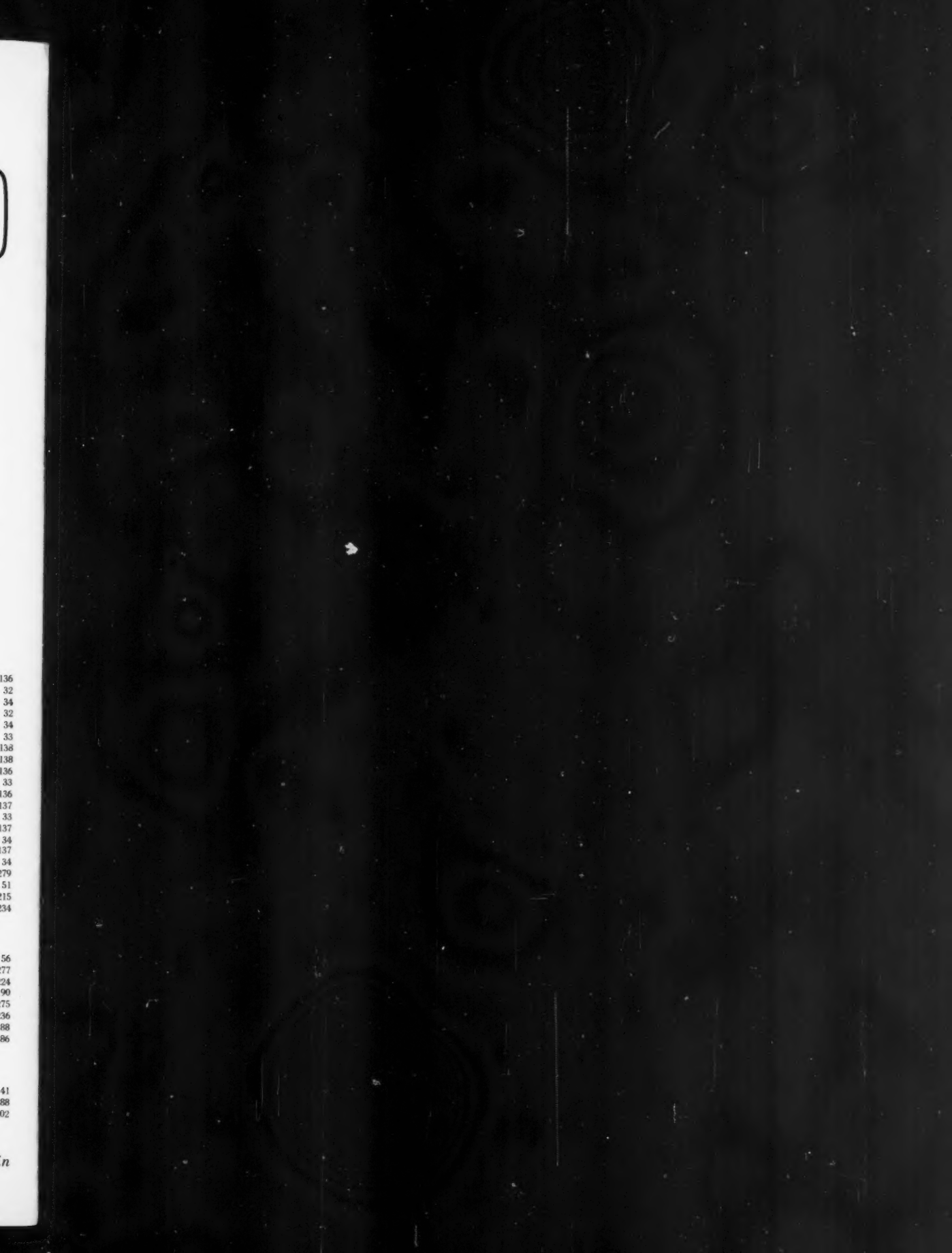
STANDARD REFERENCE MATERIALS

α Quartz (June) ... 136
Bilirubin (Feb.) ... 32
Calibrated Glass Beads (Feb.) ... 34
Fe-3 Si Alloy Microprobe Standard (Feb.) ... 32
Fluorspar (Feb.) ... 34
Fused Silica (Feb.) ... 33
Glass and Liquid Filters for Spectrophotometry (June) ... 138
Iron Foil Mössbauer Standard (June) ... 138
K Cl (June) ... 136
NBS–ICTA SRM's (Feb.) ... 33
Plutonium Metal (June) ... 136
Stainless Steels (June) ... 137
Standards for Specular Spectral Reflectance (Feb.) ... 33
Strontium Carbonate (June) ... 137
Sulfur in Fuel Oil (Feb.) ... 34
Tin Coatings on Steel (June) ... 137
Titanium Alloy (Feb.) ... 34
Stratton and Rosa Awards (Dec.) ... 279
Stronger Bonds Between Plastic Teeth and Dentine Bases (Mar.) ... 51
Study Indicates Need for Safer Matches and Lighters (Sept.) ... 215
Sulfur Dioxide Pollution Monitor Developed (Oct.) ... 234

T

Testing Gas-Tube Lightning Arresters (Mar.) ... 56
Thermal Detector, Scanning (Dec.) ... 277
Thermocouple Tables, Improved (Sept.) ... 224
Titanium Studied for Physiological Uses (Aug.) ... 190
Topografiner Developed (Dec.) ... 275
Towards International Standardization (Oct.) ... 236
Trace Metal Analysis (Apr.) ... 88
Transportation in the Northeast Corridor (Aug.) ... 186

U–V

Ultrasonic Simulation of High Velocity (Feb.) ... 41
Unified 3-Dimensional Measurement Program (Dec.) ... 288
Viscosity, Absolute Measurement of (May) ... 102

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